Copper thermite!

In a previous post I described how to carry out a silicon thermite reaction to obtain small amounts of silicon metal. In this post I'll describe a *copperthermite reaction, based on the same principles. Those uninitiated in thermite reactions are encouraged to read the* silicon thermite post first to get a good idea of the basics.

In a copper thermite reaction, copper oxide is reacted with aluminium powder to yield pure copper metal and aluminium oxide (or alumina), accompanied by a great deal of heat. The word equation is therefore:

copper oxide + aluminium ---> copper metal + aluminium oxide (+ heat of reaction)

In the case of copper, this metal and chemical element yields two distinct types of oxides, one known as *copper (I) oxide*, the other as *copper (II) oxide*. The former is also known as cuprous oxide, the later as cupric oxide. Their chemical formulas are respectively Cu_2O and CuO.

Copper thermites are notoriously *exothermic*, i.e. they produce lots of reaction heat. Of both oxides, the copper (I) oxide is the one that generates the least heat and that's why I chose to run it today.

In chemical terms the balanced reaction equation is:

$3\ Cu_2O + 2\ Al \text{ ---> } 3\ Cu + Al_2O_3 + \Delta H$

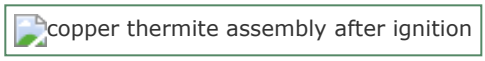
(with ΔH [delta H] the reaction heat).

The reaction equation allows to calculate the stoichiometric ratio between the amount of copper (I) oxide and aluminium powder. This ratio *Cu_2O:Al* is approximately *8:1* (by weight).

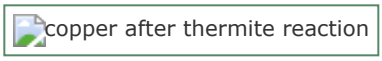
copper thermite assembly before ignition

I mixed a total mixture amount of 36.5 g, just enough to fit in a defunct egg cup. For safety reasons, the charged egg cup is then embedded in a sand-filled steel bucket (see assembly to the right). A piece of magnesium ribbon, frayed at the edges for easier lighting, was placed right in the mixture and the whole assembly placed at a safe distance from anything inflammable, in my back garden.

After lighting the magnesium fuse, I removed myself to a safe distance. The mixture ignited swiftly and burned right through with bright light and considerable sparks, in a matter of 5- 10 seconds flat. Too short a time to take any pictures but you can see a video and pictures of a similar copper (I) thermite reaction here (scroll down a little).


copper thermite assembly after ignition

Here's the assembly (right) minutes after the reaction. The reaction heat is so intense, the copper metal forms in the liquid state because the burning mixture's temperature well exceeds the melting point of copper metal (1084 C, 1954 F).
Look closely and you'll see a surface-oxidised blob of solidifying copper metal in the centre of the egg cup.


copper after thermite reaction

Here are parts of the egg cup (shattered due to thermal stress) after soaking in brick cleaner. Brick cleaner or patio cleaner contain hydrochloric acid which removes the copper oxidation and also dissolves the aluminium oxide, leaving the pure copper metal behind. The blob of copper in the centre of the picture is the same one pointed to in the paragraph above. A clean 1 penny coin is included for comparative purposes.